

ADVANCED PHOTON SOURCE

PROPOSAL FOR UPGRADING THE

RADIATION SAFETY OF X-RAY LABS

N. Friedman

July 1991

I. PRESENT STATUS

There are two adjacent x-ray labs in building 360, each having two entrance doors. Lab A240 has two x-ray machines and lab A248 has one. All machines are equipped with sliding safety windows and microswitches to monitor the state of the windows - open or closed.

Two modes of operation are possible.

1. Secure Mode in which all safety windows are closed as indicated by the microswitches. This satisfies the interlock system, allowing the high voltage power supply to be turned on.

2. Bypass Mode in which the interlock system is overridden by a key-controlled selector switch and high voltage can be turned on with machine hutch window(s) open.

The bypass mode is potentially unsafe because it is possible for an operator to leave a running instrument unattended while the windows are open. Thus, it is possible for someone entering the lab to expose themselves to x-rays.

II. POSSIBLE SOLUTIONS

Two different schemes are presented here, both of which can greatly enhance the safety of the labs. I personally favor the second.

A. Solution 1

The first scheme is based primarily on the Cardkey electronic ACCESS CONTROL system. The five basic system components are:

- 1) Cards
- 2) Reader/Terminal Interface
- 3) Intelligent Terminal Controller
- 4) Door Hardware
- 5) Programming/Report Generating Equipment

- 1) All authorized personnel would be issued a Wiegand wire technology security card. These cards have a wide environmental window (i.e., are not affected by temperature, humidity, vibration, or corrosion) and are usually not affected by normal, everyday magnetic fields.

Basic encoded information includes:

- a) Facility code - unique to ANL,
- b) Serial number - a sequential number from 1 to 65535 that is issued to each card holder.

2) Each Wiegand Effect card reader is mounted on a solid wall mount kit (569-B) on the exterior side of each door. Associated interface electronics are mounted within the secured area. This "dual-stage" configuration insures that the integrity of the secured area is maintained should an attempt be made to tamper with the reader. The reader is equipped with status lights that indicate when an access attempt is either authorized (green) or unauthorized (red).

3) Control of two doors can be combined into one unit by employing a Dual Smart Terminal Interface (DST). This provides reduction in hardware and installation costs. One DST has to be installed in each x-ray lab. Use of the DST minimizes cabling costs through localization of the following facilities at the access point:

- * Local Facility Code verification
- * Programmable alarm shunt timing (may be set up to 99 seconds)
- * Programmable access time period (may be set up to 99 seconds)
- * Auxiliary Access switch circuit. We can use it for an Emergency. Only Entry button on the exterior. I also recommend to parallel that switch to a dry contact, normally closed switch on the interior in order to attain a redundant free egress
- * Door-open detect monitoring (0.5 second pulse duration required)
- * Thirteen additional alarm inputs (I would like to see at least two used; one for fire alarm release, and another for an Emergency. Only Entry button
- * Two relays for electric door strike (one for each door)
- * Void/Valid status lamp drivers for each door (green/red status indicators on a reader module, visually signals access response)

4) The DSTs, are in turn, connected to an Intelligent Terminal Controller D600-2 that includes a comprehensive integrated data-base capability,

provides 4,000 random card capacity (expandable to 16,000!), and, in standard configuration, supports 8 readers (with the addition of Multi-Terminal Interface expandable to 16).

Features include:

- * Programmable transaction history storage,
- * Alarm monitoring and annunciation,
- * Programmability of access and access alarm shunt times,
- * User-definable password protection,
- * Rapid local card add, delete, display, or change,
- * Real-time clock,
- * IN-X-IT (Entry/Exit) feature (anti passback),
- * Local printer option, and comprehensive reporting capability,
- * Battery backup for memory retention of up to 8 hours.

5) There are Compaq class 386 computers in the x-ray labs. These machines are IBM-AT compatible and run at a frequency of 20 MHz. They will support a software package (#360-SX) available from Cardkey Systems Inc. for \$595.00. The program has Terminal Emulation and Complete Documentation capabilities. With this, we would not need to purchase a programmer (\$675.00) or another printer.

Notes

1) In order for a history to be of value, the D600-2 must be connected to a printer. The D600-2 can be programmed to print out a message for every door transaction or only for unusual events.

2) A hard copy is created and a local audible alarm sounds when:

- a) Fire alarm goes off,
- b) Emergency entry takes place,
- c) Door remains open beyond specified access time (e.g. 30 seconds), to avoid doors being propped open,
- d) Door opens without the normal use of a cardkey,
- e) Attempts to tamper are detected.

3) The system can be expanded to include other locations where access control is desirable, utilizing the same Intelligent Terminal Controller D600-2. The Reader/Terminal can be located up to one and a half miles (2.4 Km) from D600-2. If terminals must be located more than 1.5 mi from the D600-2 or another terminal, the data lines can be extended by using a leased telephone line with a modem at each end for interfacing.

4) The system is fail-safe, and, in the event of a power failure, a solenoid bolt type lock is de-energized, unlocking the door.

5) Configuration Protocol doesn't allow wiring Smart Terminal Interface modules in a high-security loop for bi-directional (forward and reverse) polling. So DSTs must be directly wired to the Intelligent Terminal Controller in a fanout configuration.

6) Electric locks for doors would be provided by the ANL locksmith department. Also, transformers, doorbells, pushbuttons, warning lights, buzzers, wires, conduits, and any other minor hardware could probably be supplied by various ANL departments.

Additional Arrangements

Warning displays "X-RAYS ON" are to be installed above all four doors on the exterior side. The displays outside lab A248 will light up whenever an x-ray machine high voltage power supply is switched on (regardless of shutter position). The displays outside lab A240 will light up if either of the two H.V. power supplies is ON. Similar warning displays should also be mounted within the labs (one in each).

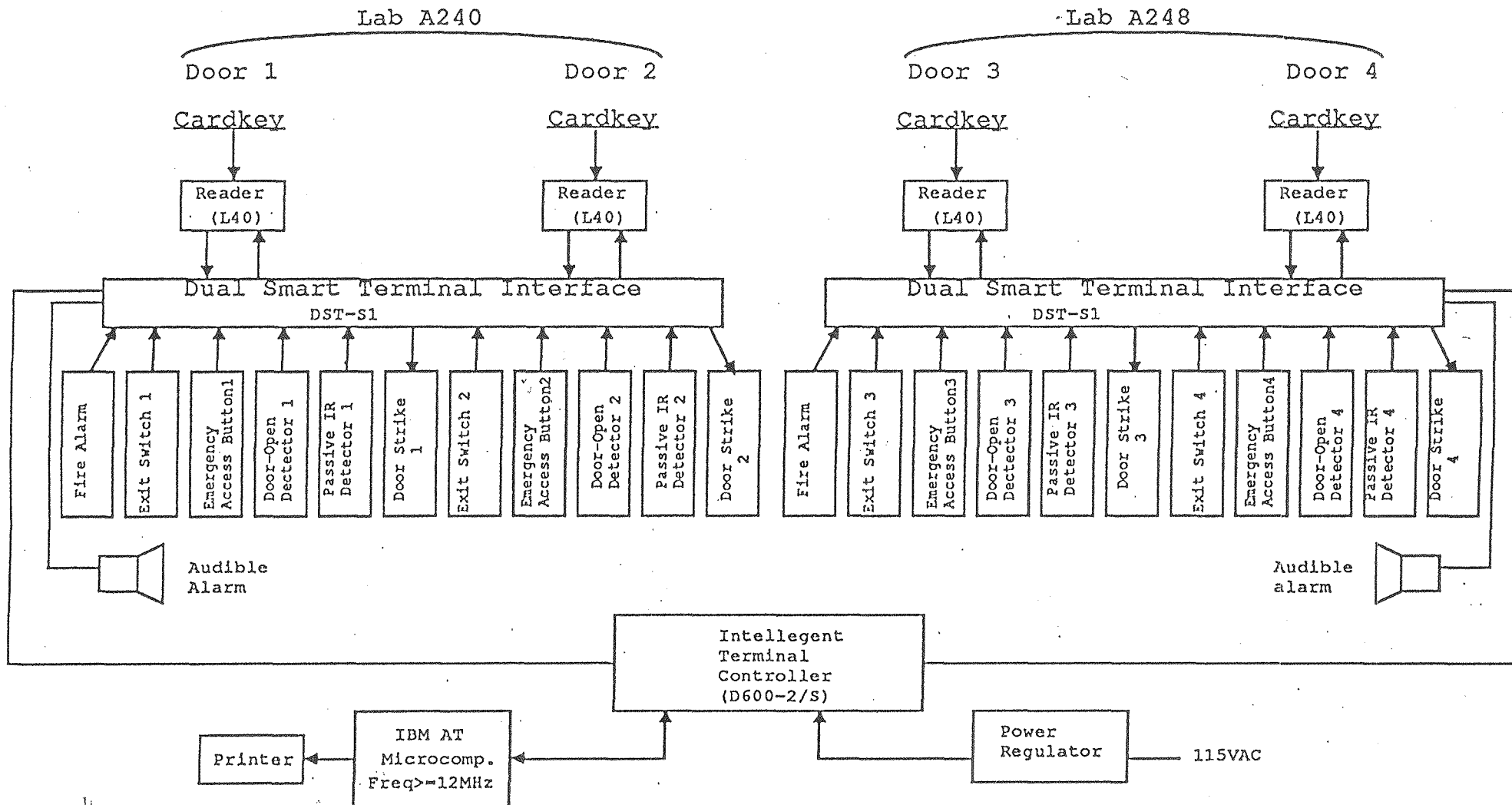
All doors are to be equipped with doorbells. Unauthorized people will need to ring the doorbell to gain access to the x-ray lab. The person admitting an unauthorized individual into the lab is responsible for his/her safety.

Procedures emphasizing operational and radiation safety aspects must be written, distributed to all whose work involves entry into x-ray labs, and posted visibly within the labs. Compliance with these procedures must be enforced.

Shortcomings

1) This system will only limit access to the labs to authorized personnel. Should an operator start the machine with interlock overridden and leave the area, the unit will continue operating.

Block diagram of access control system for x-ray labs A240 and A248 in building 360



2) Present interlock chains have no built-in redundancy, and this important radiation safety characteristic is not being addressed by the proposed system.

3) No printer is constantly on-line.

Electrical Requirements

Reader: Power provided by Dual Smart Terminal Interface DST-S1

DST-S1: 115VAC +/-10% at 0.5A, 60 Hz

Access Relay: 2 Amps at 24 VAC (Can use DC power by adding a rectifier)

Tamper Switch: 3 Amps at 30 VDC

Auxiliary Access/Exit Switch: 0.25 Amp push button, SPDT, dry contact

Alarm Contact: 5 mA at 5 VDC, NC dry contact

D600-2: 115 VAC +/-10% at 1.0 A, 60 Hz

Pricing

Major Equipment

<u>Description</u>	<u>Quantity</u>	<u>List per Unit</u>	<u>List</u>
Intelligent Terminal Controller (D600-2/S)	1	\$ 1,636.00	\$1,636.00
Software Package	1	595.00	595.00
Power Regulator (*)	1	260.00	260.00
DST-S1	2	612.00	1,224.00
Card Reader	4	404.00	1,616.00
Solid Wall Mount Kit (back box)	4	126.00	504.00

<u>Description</u>	<u>Quantity</u>	<u>List per Unit</u>	<u>List</u>
Passive IR Detector	4	400.00	1,600.00
Pushbutton (Enter/Exit)	8	54.00	432.00
Door-Open Detector	4	8.00	32.00
Weagan Card	~40	3.82	<u>152.80</u>
		Subtotal	8051.80

(*) Cardkey Systems' price; should be possible to get for less.

Additional equipment is required, including two small transformers, four electrical locks, two doorbells, two buzzers, six warning displays, cables, interconnect terminals, and other. Approximate cost is \$ 1,000. So, we are looking at a total of ~ \$9,000 in equipment.

In my view, installation could be done by ANL personnel. Cardkey Systems' charge for the labor would be \$3,360.00, which includes wires, conduits, and mounting conduits on wall surfaces.

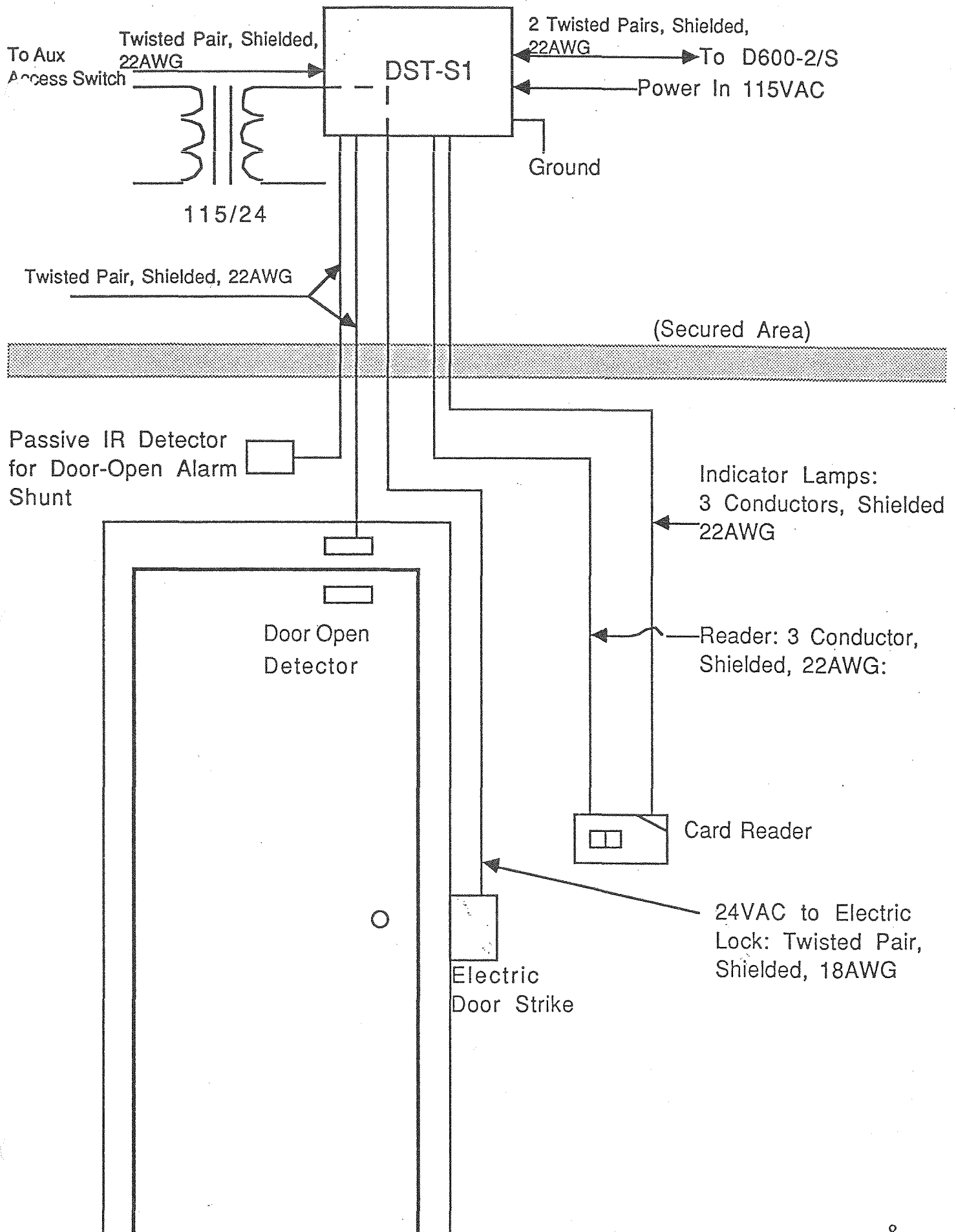
Training by the Cardkey Systems people is available at the cost of \$300.00. They would spend half a day with up to four lab people.

B. Solution 2

The conceptual design presented in this part of the proposal is built around a Programmable Logic Controller (PLC) - the brain of the system. By integrating the intelligence of the PLC, smart interface terminals, electromagnetic door locks, and existing relay-type interlock logic, a truly versatile and powerful security and control system is created. The four basic components are:

- 1) Programmable Logic Controller (PLC)
- 2) Programming & Documentation Software
- 3) Programming Device
- 4) Operator Interface

Wiring Diagram



1) The selection of a PLC was narrowed down to two small controllers, Allen-Bradley's (A-B) SLC 500 and Modicons Compact 984 (also known as Mini 984). Applications of both PLCs were analyzed in detail and found suitable for the task, though A-B is more expensive. I am basing this proposal on the Compact 984 simply because operator interface devices, made by Panel-Tec, readily speak Modbus¹ communication protocol. But, interfacing to the A-B SLC 500 is certainly possible by employing additional hardware. About the only difference is that a Modicon controller internally numbers the bit position in a Holding Register from 1 to 16, left to right, whereas Allen-Bradley controllers number them right to left.

Compact 984 has a modular design that can fit up to 256 discrete I/O in an area of only 1.5 square feet. CPU memory is 4K words of battery-or-EEPROM-backed plus 2K registers to handle any application in its I/O range. It has a time-of-day clock and Modsoft integrated development & troubleshooting software. Modsoft provides on-line and off-line ladder logic programming and full documentation. The Compact 984 also features built-in Modbus communications interfaces that enable us to link the PLC to a computer. We can then upload, download, or edit the control program across the network while all data transfer continues. Data transfer rate is 19.2K baud.

Input/Output modules are available in densities of 4, 8, and 16, discrete points, 4 points of analog input and 2 points of analog output. The compact 984's modularity is ideally suited to applications that may require future change or expansion. Up to three expansion subracks can be attached to the main subrack for a total of 18 possible I/O slots (256 discrete inputs/outputs, any mix).

Input ratings: 110VAC, 220VAC, 24VDC contact

Output ratings: 24-230VAC, 24-115VAC, 24VDC, contact

Output current, Amps/point: 5A, 1A & 2A

All I/O Modules equipped with LED status indicators

Power Supply Module: Input 95-270VAC, 47/63 Hz
Output 24VDC @ 1A

Integral P.S.: Input 20-30VDC @ 1A Full Load
Output 5VDC @ 3A to the I/O Bus

¹Modbus is a registered trademark of Gould-Modicon, Inc.

Approximate I/O Requirements:

50 discrete inputs, both AC and DC
30 discrete outputs, both AC and DC

2) Modsoft for Compact 984 is an integrated programming software environment that includes on-line/off-line programming and full documentation. Modsoft allows the user to create and edit ladder logic programs using Modicon Ladder Logic symbol names. A Reference Data editor is available for displaying and modifying data either on-line in the controller or off-line in a file.

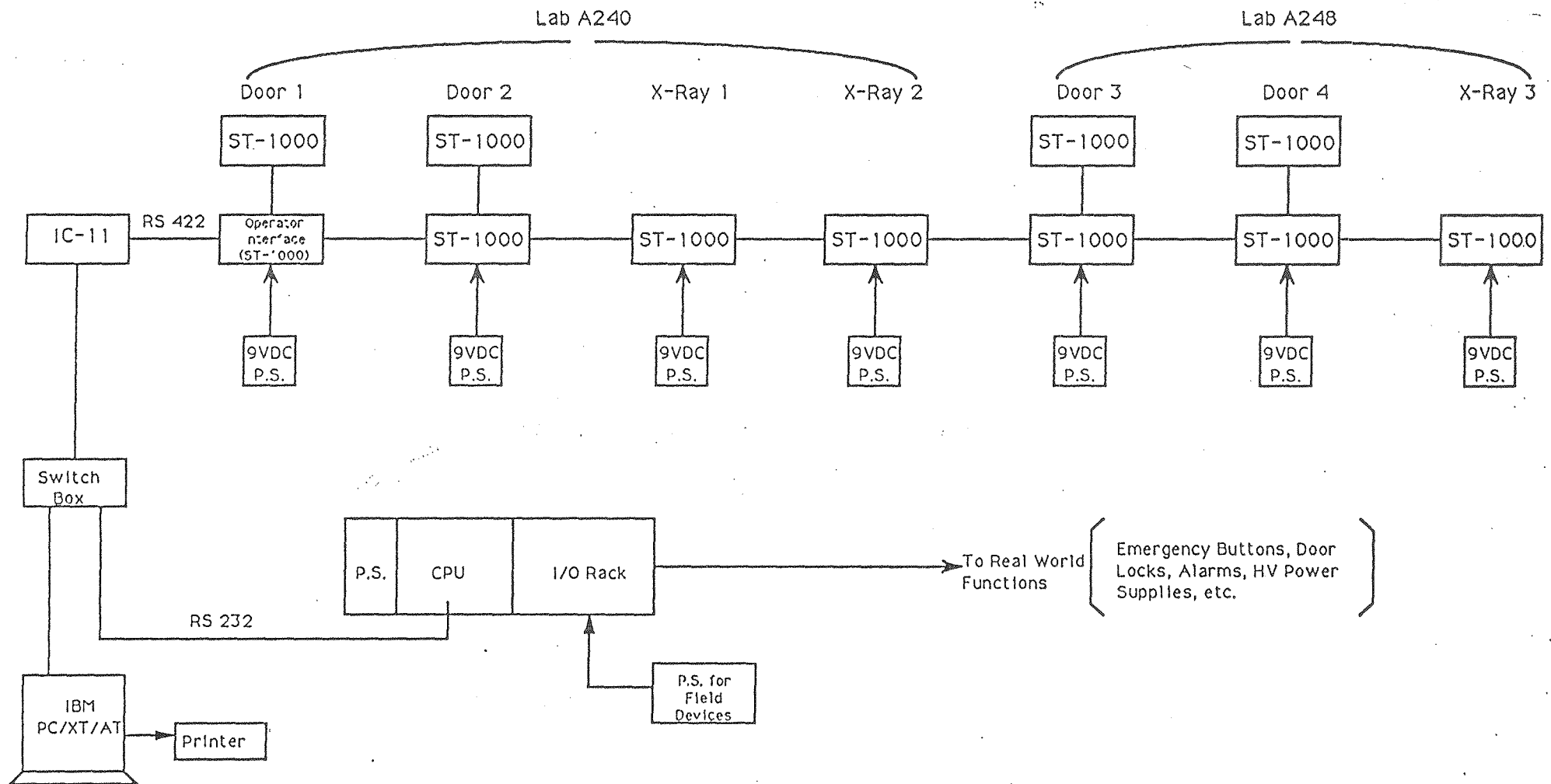
3) Designed to run in a DOS environment, Modsoft is compatible with IBM desktop and laptop personal computers. It accesses the 984 through an available serial port and the Modbus port on the 984 CPU. IBM AT compatible computers are available in x-ray labs and can be used for programming, as well as for documenting and storing the control program on disks.

4) Panel-Tec Interface Terminals-Modbus-compatible devices will be acquired with the idea of local high-voltage power supply control, as well as lab access and egress. Pushbuttons, panel lamps, numeric entry, and an alphanumeric display (20 fixed or 64 scroll characters) are all incorporated into a single device. This makes the Panel-Tec ST-1000 terminal a multifunction operator interface that can satisfy a wide variety of needs. It has 12 pushbuttons and 12 tri-state LEDs (on/off/blink). The device doesn't use up PLC I/O points because it communicates directly to Holding Registers within the controller. While not as flashy as a color graphics device, most of the programming of the device occurs in the PLC which treats Panel-Tec I/O as if it were hardwired.

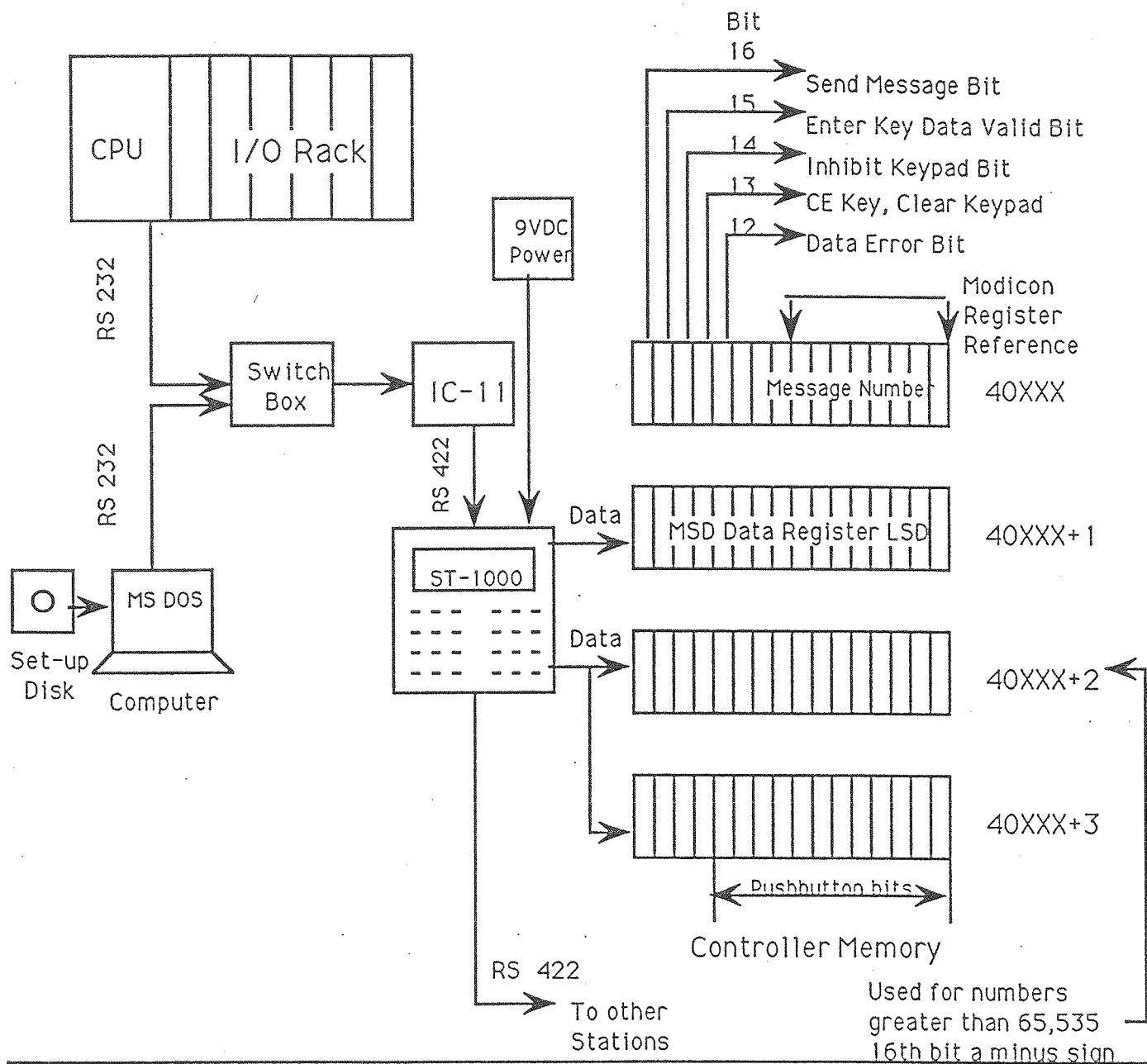
ST-1000 is capable to distribute power to interface panels and to serve as a communications link between panels and a programmable controller or computer. It provides an RS422 serial port for "one wire" connection to the programming port of the controller (via an RS32/RS422 converter) or serial port of the computer. In general, RS-232 communications are reliable up to about 75 feet @ 9600 baud (baud=number of binary bits per second). However, when connecting equipment over longer distances (75-4000 feet), it is advisable to use the RS-422 communications link which is capable of communicating up to 4000 feet (3/4 mile) @ 19,200 baud. This method of long distance interfacing is an inexpensive solution to the high cost of using a pair of modems at both ends of the cable.

The devise also provides the network with remote operator station capability. Up to 32 remote stations may be located within 4000 feet of the controller or computer.

Access control and safety interlocks for x-ray labs A240 and A248 in building 360
system configuration



Engineering Specification Diagram and Holding Register Mapping



Description	Part#	Unit Liset	QTY	SubTotal List
Display & Keypad	ST-1000	\$995.00	11	\$10,945.00
Power Supply	PPS5./6-1	\$195.00	7	\$1,365.00
RS232/422 Converter	IC-11	\$193.00	1	\$193.00
				<u>\$12,503.00</u>

Total price after 30% discount=\$8,752.00

PLC Pricing

<u>Description</u>	<u>Part#</u>	<u>OYT</u>	<u>List/Unit</u>	<u>List Price</u>
4K Compact 984 CPU with Modsoft Programming/Documentation	PC-0984-140	1	1200.00	1200.00
Primary Subrack-3 module	AS-HDTA-200	1	165.00	165.00
Secondary Subrack-5 module	AS-HDTA-201	1	165.00	165.00
Bus Extension Cable	AS-WBXT-201	1	70.00	70.00
Discrete Input Module 8 pt, 115VAC	AS-BDEP-209	2	115.00	230.00
Discrete Input Module 16 pt, 24VDC	AS-BDEP-216	2	160.00	320.00
8 pt Relay Output Module	AS-BDAP-208	3	180.00	540.00
Total List:				\$2,890.00
Price after 33% discount:				\$1,936.30

During the configuration process, the editor automatically maps each module into holding register locations starting with register 12. Each module requires a certain number of consecutive registers, typically from two to five. The next module to be added then maps into the next available register locations. For example, the alphanumeric module requires three consecutive registers. If it is the first module to be added to the configuration editor, it will reside in Holding Registers 12, 13, and 14. The next module to be mapped then start at Holding Register 15. This process continues until all modules have been added to the editor.

Functional Description of the Control Task

- 1) Display and Control Interface Modules are to be installed by each of the lab doors, both on the exterior and interior, and one for each x-ray generator.
- 2) Each authorized user of the x-ray lab is assigned a 4-digit PIN code.
- 3) The PLC continuously monitors/controls the status of the doors, door locks, emergency buttons, high-voltage power supplies, bypass keys, shutters,

shutter status indicators, x-ray unit enclosures (limit switches), x-ray level monitors, audible alarms, and warning lights.

4) In order to achieve redundant interlock chains present hard-wired interlock logic is to be series programmed into the PLC.

5) Failsafe design is implemented. Meaning, for example, that if the communication with the processor fails, shutters will close (manual takeover of controls is provided), and lab doors will unlock.

6) In order to enter the lab, the "Access Request" button on the control panel must be depressed and, upon a prompt from the PLC, the PIN number must be entered. Control logic will verify the validity of the PIN code and either grant or deny access. In either event, an appropriate message will be communicated to the person seeking entry via module display. Three consecutive tries will be allowed. If a valid PIN is entered, a message "Please press OPEN DOOR button" will be displayed. The pressing of the control button will unlock the door for 30 seconds. Information about who entered the lab and when will be stored in the processor memory and printed out in a hard copy form.

7) Override of x-ray machine interlocks is done in two steps. First by closing the key-controlled switch and then via the interface panel. As with the door locks, in order to request an override a valid PIN has to be entered. If the control logic is satisfied, it will respond with the message "Override Granted, Press OVERRIDE button." The operator will then press OVERRIDE and the message "Interlocks Overridden. HV P.S. Turn On Enabled" will be displayed. Only then can the high voltage power supply be turned on by depressing the corresponding control button. I am intentionally not going into every detail of the control functions in order to avoid excessive wording. At this moment, the PLC "knows" who has overridden the interlocks and when. That transaction is then printed out by the printer for possible future checks.

8) It is also necessary to use a PLC interface panel and a PIN number in order to exit the lab. If the user responsible for bypassing the machine interlocks attempts to leave the lab while the machine is still in open beam mode, a warning message will be displayed on the door control panel. An audible alarm will sound and a hard copy of the alarm message will be printed out. If no corrective action is taken, the shutters will close and eventually, after a preset time delay, the x-ray generator power supply will shut off.

9) Various interlock trips will be provided. For example, if the radiation enclosure is opened while the x-ray unit is in closed beam mode (i.e.,

P.S. is not overridden), a warning is issued on the interface display, an alarm sounds, and the shutters close. Also a hard copy of the alarm message is printed.

10) X-ray level monitors will be installed within the radiation enclosures. Should radiation levels exceed a certain threshold, the shutters will close, and, eventually, high voltage will be cut from the x-ray tube if corrective action is not taken. Of course, a warning and an alarm will be triggered as well.

11) Warning signs "X-RAYS ON" must be installed on the exterior of each lab. Signs for a particular lab will be illuminated whenever a HV power supply in that lab is on.

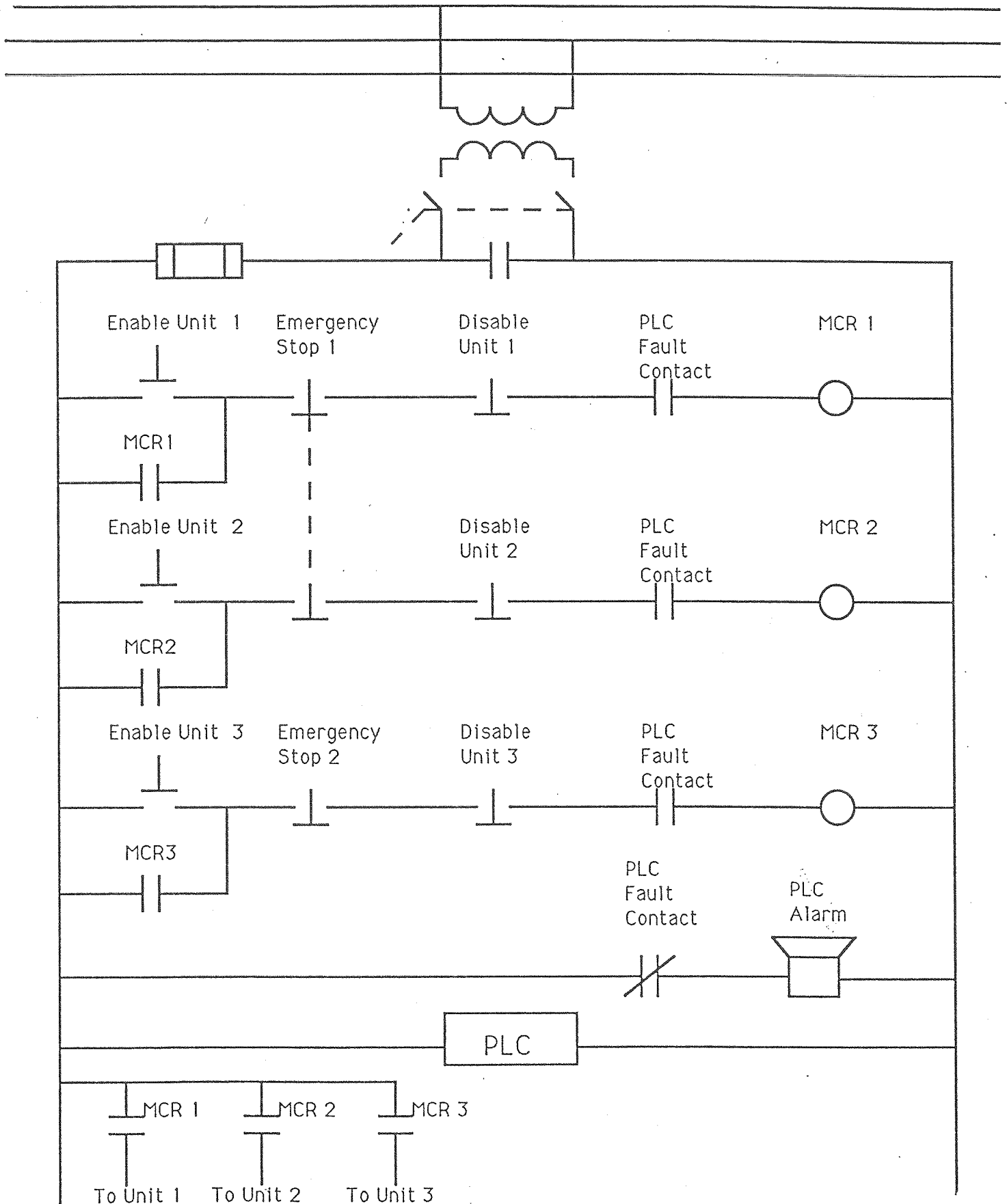
12) In emergency situations, such as a fire alarm, power outage, CPU failure or communications error, the system will fail in a safe manner, i.e., doors will unlock, shutters will close, and power supplies for x-ray units will turn off. After normal operation conditions are restored, system elements will not change their state (e.g. high voltage won't be reapplied to the x-ray tube automatically), and it will be the responsibility of a qualified operator to bring the system back on line.

Safety Wiring

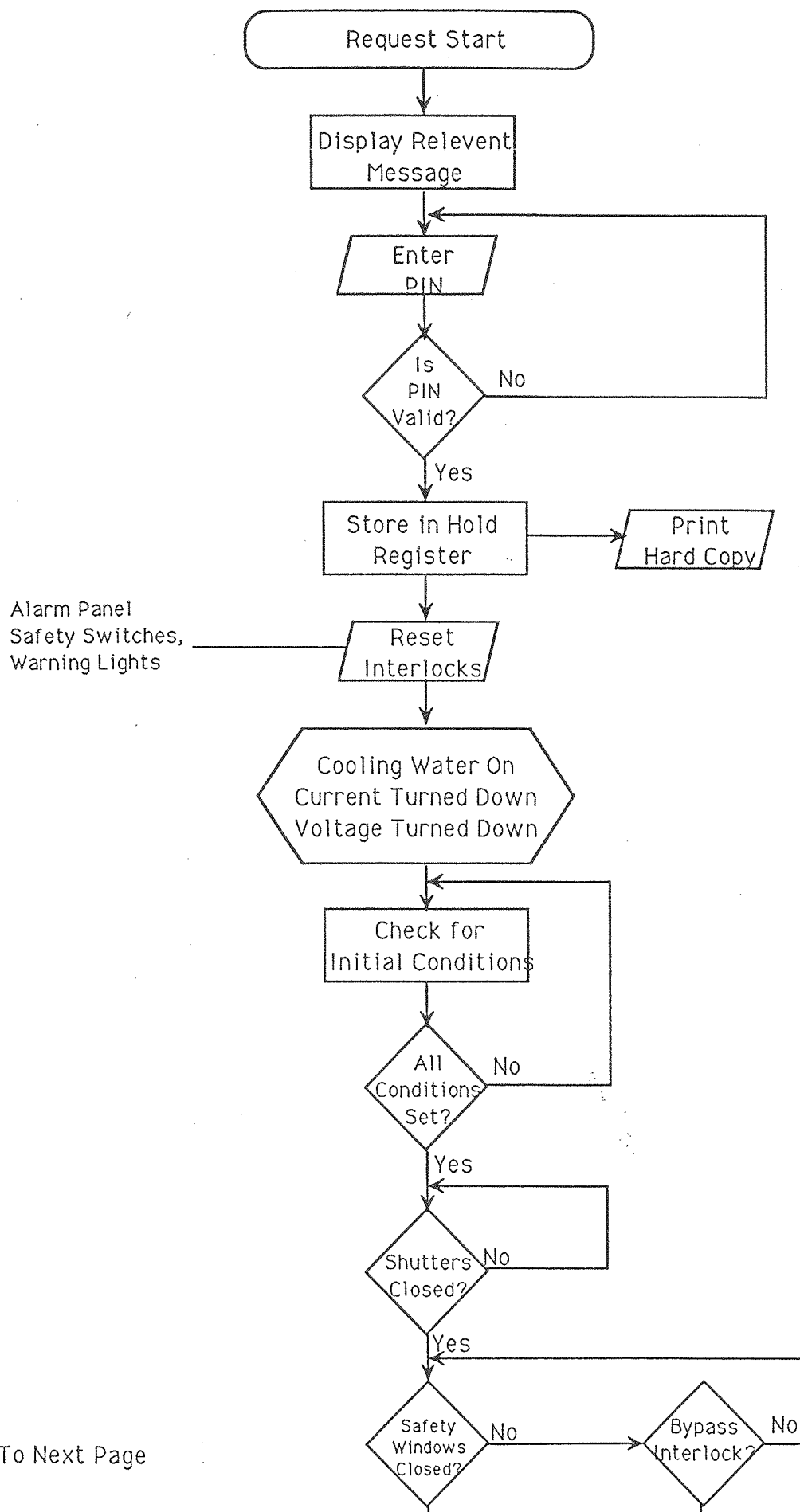
Emergency overrides on locks and power supplies must be installed. Emergency buttons must be provided on the exterior and interior sides of each door for emergency access and egress, and there must be one button for each high-voltage P.S.

The emergency components should be hardwired, principally for safety purposes. If for some reason, the controller is faulty and there is an emergency situation, the system can be shut down without PLC intervention. I recommend that emergency stop circuits be incorporated into the system for every x-ray machine. These emergency stop switches will be wired into master control relays (MCR) that will remove power from the I/O system in an emergency. The MCR circuit will be extended by placing the PLC fault relay (closed during normal PLC operation) in series with any other emergency stop conditions. This enhancement will cause the MCR circuit to drop the I/O power in case of a PLC failure (memory error, I/O communication error, etc.).

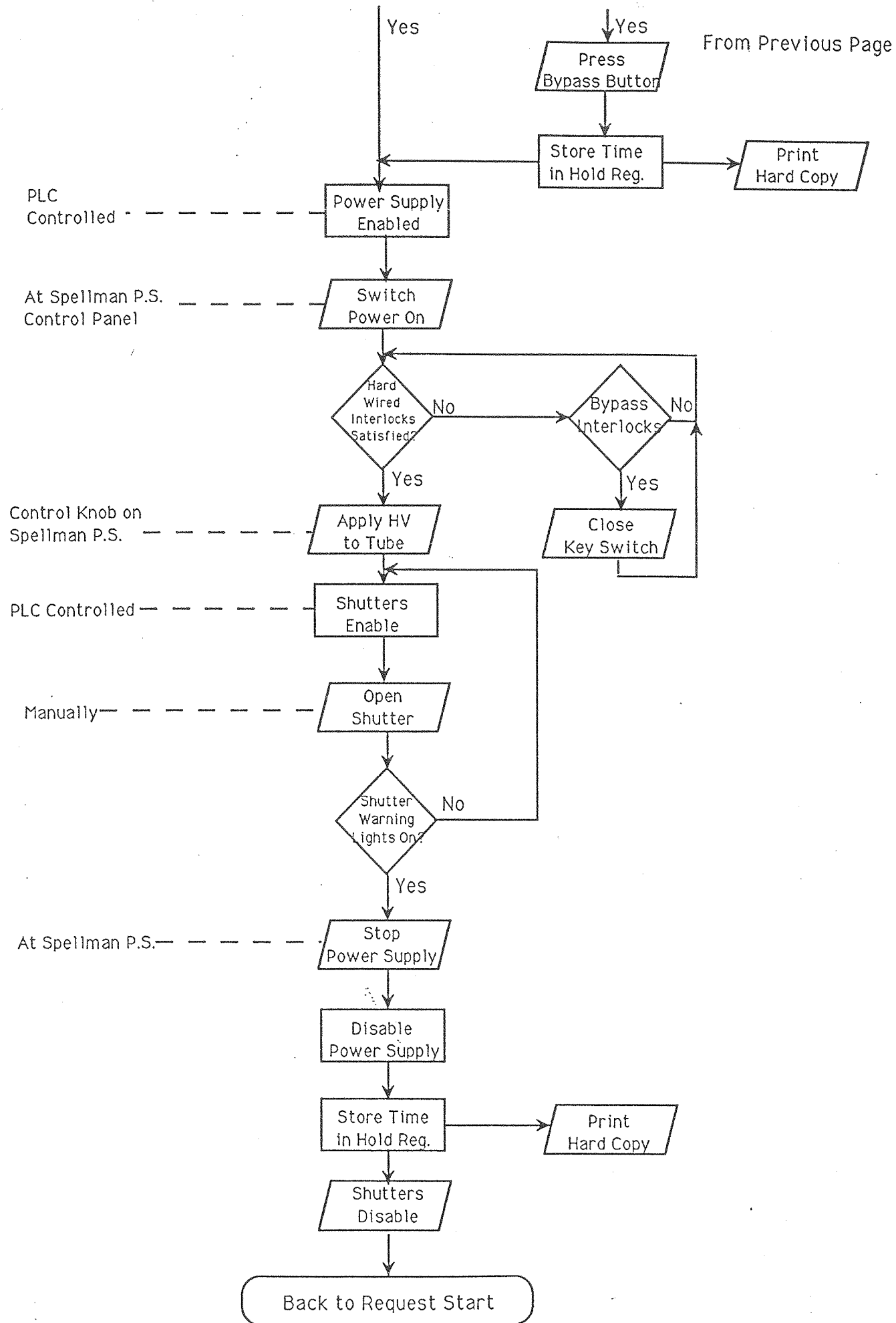
Illustration of Safety Wiring Diagram with Separate MCR Control for Each X-Ray Unit



X-Ray Generator P.S. and Shutter Control Flow Chart



To Next Page



TOTAL EQUIPMENT COST

PLC and Accessories.....\$1,936.30

Operator Interfaces and Accessories\$8,752.00

8 Emergency Buttons..... \$432.00

Additional Equipment.....~\$1,000.00

(limit switches, electrical locks,
doorbells, buzzers, warning signs,
terminal blocks, wire, connectors,
relays, and other minor hardware)

Total equipment cost is approximately \$12,120.00

Notes

1) For comparison, total equipment cost of the system described in Solution I (Cardkey electronic access) of the proposal is approximately \$9,000.

2) The system described in Solution 2 (Programmable Logic Controllers) retains all the useful features of the system using the Cardkey equipment described in Solution 1.

3) Panel-Tec smart terminals use Modbus serial data protocol. In order to communicate with an Allen-Bradley programmable controller, the PLC must be equipped with a BASIC card. That card is not available for small A-B controllers at the moment. It is expected to be on the market beginning 1992 at a price of ~\$1,250. After a discount, the total cost of A-B PLC equipment would be \$3,172. That is \$1,236.00 or 63.8% more expensive than the Compact 984, which argues in favor of using Modicon's Compact 984 controller (see Appendix for catalog information).

4) Small Programmable Logic Controllers typically do not support remote I/O drops. However, when a new x-ray lab is set up in Building 362, the Radiation Safety System can be easily expanded by buying an additional Compact 984 processor with 1.5K memory and 256 discrete I/O capacity for only \$400.00. This is a much better solution than running long wires across the buildings.

III. CONCLUSION

I think that, despite being more expensive, a Programmable Logic Controller based (PLC-based) system is the better choice in the long run. There is really no other way to introduce "intelligence" into the system. The advantages of a PLC-based system include:

- 1) More reliable. Solid-state electronics outperform electro-mechanical devices by far.
- 2) It is the only way to control the situation in which the user responsible for an open-beam mode of operation attempts to leave the lab while the machine interlocks are overridden.
- 3) Redundant interlock chains are achieved.
- 4) Tremendous flexibility is attained. Rapid alterations of complex interlock patterns can be designed and installed in real-time. One interesting peculiarity of the Modicon PLC family is the users' ability to change the program in the processor while that program is running, provided that only one network (page) at a time is changed.
- 5) Inherent self-documentation of the PLC "ladder" logic control programs.
- 6) As is always the case with Programmable Logic Controllers, once available, more and more controls, devices, functions will be incorporated. Eventually, the role of the PLC will expand beyond the immediate objectives of this project.

Appendix

Catalog Information on Modicon Compact 984 Controller

Modicon A120-Series I/O

Model	Voltage Range (Max Current/Point)	Number Input Channels	Number Output Channels	Number per Common	I/O Power Required mA @5V Internal	Required Addressing Disc. I/O	Reg. I/O
Discrete Input							
AS-BDEP-208	230 VAC	8	0	8	<30	8/0	0/0
AS-BDEP-209	115 VAC	8	0	8	<30	8/0	0/0
AS-BDEP-216	24 VDC	16	0	8	<15	16/0	0/0
AS-BDEO-216	24 VDC	16	0	0	<15	16/0	0/0
AS-BDEP-220	24 VDC Fast Response (.5 ms)	16	0	8	<15	16/0	0/0
Discrete Output							
AS-BDAP-204	Relay NO (2A) 24-110 VDC, 24-230 VAC	0	4	1	<25 (150 @ 24 V Ext.)	0/4	0/0
AS-BDAP-208	Relay NO (2A) 24-110 VDC, 24-230 VAC	0	8	1	<60 (150 @ 24 V Ext.)	0/8	0/0
AS-BDAP-209	115 VAC (1A)	0	8	8	<88	0/8	0/0
AS-BDAP-216	24 VDC (.5)	0	16	8	<50	0/16	0/0
Combo Disc.							
AS-BDAP-212	24 VDC in/Relay out	8	4	8 in/1 out	<25 (150 @ 24 V Ext.)	8/4	0/0
AS-BDAP-220	24 VDC in/ 24 VDC out (2A)	8	8	8 in/8 out	<60	8/8	0/0
Analog Input							
AS-BADU-204	± 500 mV, pt 100, 11 bit	4	0		<30	0/0	4/0
AS-BADU-205	± 10 V, ± 20 mA, 11 bit	4	0		<30	0/0	4/0
Analog Output							
AS-BDAU-202	± 10 V, ± 20 mA, 11 bit	0	2	2	<60 ($<150 @ 24 \text{ V Ext.}$)	0/0	0/2
Intelligent							
AS-BZAE-201	High Speed Counter 50 kHz @ 24 V, 500 kHz @ 5 V (RS422) Relay NO (2A) output	1	2	1 in/1 out	<100 ($<30 @ 24 \text{ V Ext.}$) Sensor PS @ 5 V & 24 V Ext.	0/0	3/3
Special							
AS-BNUL-200	Module for prewiring up to 16 pt spare slot	N/A	N/A	N/A	0	0/0	0/0
AS-BNUL-202	16 pt, < 50 V (6A) Wiring Connection Mux	N/A	N/A	N/A	0	0/0	0/0
AS-BSIM-216	Discrete Simulator (Requires 24 VDC Disc In)	N/A	N/A	N/A	0	0/0	0/0
AS-BSIM-203	Analog Simulator (Requires Analog in and out)	N/A	N/A	N/A	0	0/0	0/0

ModSOFT for Compact 984 On-line/Off-line Development Software

Description:

ModSOFT for Compact 984
Development Software:

On-line/Off-line/Documentation
Software Package For
Support of Compact 984
Controllers

Part Number:

SW-MS PB-DCA
Includes:
2 System Disks - 5.25"
format
System Disk - 3.5" format
Quick Reference Guide
ModSOFT for Compact 984
User Manual
984 Systems Manual

ModSOFT User Manual:

GM-MSFT-004

984 Systems Manual:

GM-0984-SYS

Controllers Supported:

PC-0984-120
PC-0984-130
PC-0984-145

Communication Networks
Supported:

Modbus RTU Mode (COM1 or
COM2)
Modbus ASCII Mode (COM1 or
COM2)
Modbus Plus (SA-85)
C996 DOS CoPro

Editors:

Configuration
Traffic Cop
Ladder Logic
Reference Data

Documentation Features:

Element Comments

Two 10-char Tags Plus 50-Char
Comment

Network Comments

One 20-char Tag Plus
1500-char Comment

Segment Comments

One 20-char Tag Plus
1500-char Comment

Ladder Lister Features:

Selected Segments
Selected Ladder Diagram
Symbol Table - Alphanumeric
Symbol Table - Alphabetic
Coil Cross Reference
Unused References
Configuration/Traffic Cop
Page Headers/Footers
Importable to Desktop
Publisher

Required Hardware:

IBM PC/XT, AT or compatible
☐ DOS 3.0 or greater
☐ 640 k RAM memory
☐ Hard Disk w/1.5 Mbyte
available